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ABSTRACT

A spare NASA/GSFC Astro-E microcalorimeter has been installed, tested, and run successfully on EBIT-II at the Lawrence Livermore National Laboratory. A brief overview of results including measurements by the microcalorimeter of absolute excitation cross sections, time dependent spectra, and spectra as a function of Maxwellian temperature are discussed.

Over the last decade the spectroscopy group at the Lawrence Livermore National Laboratory electron beam ion trap EBIT-II, in collaboration with the Columbia Universtiy Astrophysics Laboratory, and recently, NASA's Goddard Space Flight Center, has developed an extensive laboratory astrophysics program. Recently, a spare NASA/GSFC *Astro-E* XRS microcalorimeter has been installed, tested, and run successfully on EBIT-II (Porter et al. 2000). The microcalorimeter complements crystal and grating spectrometers making it possible to measure a broad band-width ($\sim 0.3 - 10$ keV) with moderate resolution while simultaneously measuring a narrow bandwidth ($\sim 0.7 - 1.3$ keV) with high resolution. In conjunction with the spectrometers already present at EBIT-II, the microcalorimeter has been used to measure absolute excitation cross sections, time dependent spectra, and spectra as a function of Maxwellian temperature.

The broad band-width and ~10 eV resolution of the XRS enables us to normalize cross sections to the radiative recombination (RR) photon emission. Because radiative recombination is the simplest atomic scattering process, highly-accurate RR cross sections are known for high electron-impact energies. Once normalized to the RR, our measured cross sections are, therefore, "absolute" in the sense that they are normalized to the most-highly accurate and independent process available. Some of the first results from these measurement can be found in Chen et al., 2001 and in Porter et al. 2001.

Using the ability to measure time dependent spectra with the XRS, we have studied ionizing plasmas, i.e., plasmas whose charge balance has not yet reached equilibrium. Figure 1 shows two spectra measured at different times: 1(a) is near equilibrium, and 1(b) is before equilibrium is reached. This shows that the ratio of 3s $\rightarrow$ 2p to 3d $\rightarrow$ 2p lines in Fe XVII changes dramatically between the ionizing and the equilibrium condition. It is before equilibrium is reached, i.e., during ionization, that processes such as innershell ionization and excitation play an important role in the spectra. Our ability to measure time resolved spectra makes it possible to accurately discriminate between lines emitted during ionization from those emitted during equilibrium.

We have presented a brief overview of work being done as part of the Laboratory Astrophysics program at the LLNL EBIT-II. Other work includes using the Maxwellian simulation mode of EBIT-II to create and measure spectra emitted from plasmas at specific electron temperatures to determine the correct charge balance for a given Maxwellian temperature, and measuring the relative intensity of O VIII Lyman α to Lyman β (Gendreau et al. 2001). Laboratory data of these types will make the analysis of astrophysical spectra more reliable.

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REFERENCES

Chen, H., et al. J. 2001, Astrophys. J., in prep

Gendreau, K. C., et al. 2001, Astrophys. J., in prep

Porter, F. S., et al. 2000, in Proceedings of the 45th annual SPIE meeting on Optical Science and Technology (SPIE Press), in press

Porter, F. S., et al. 2001, in Proceedings of a New Century of X-ray Astronomy

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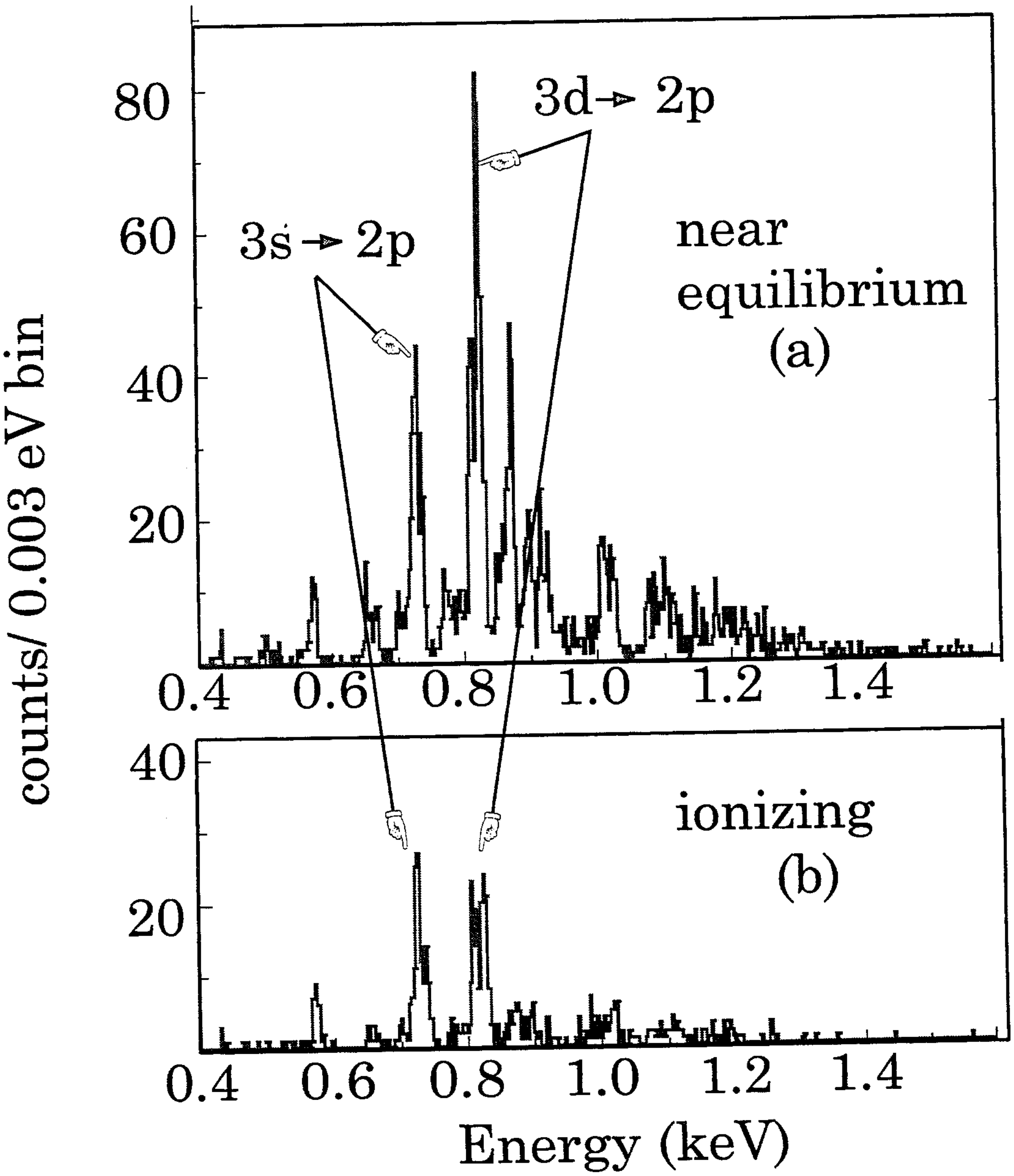

Fig. 1.— (a) Iron spectrum measured with the XRS microcalorimeter measured near equilibrium for a quasi-Maxwellian energy distribution. (b) Same spectrum as (a) during ionization. Notice the large difference between the 3s $\rightarrow$ 2p and 3d $\rightarrow$ 2p lines in Fe XVII.

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